Chemical and Biological Microsensor Development at Sandia National Laboratories

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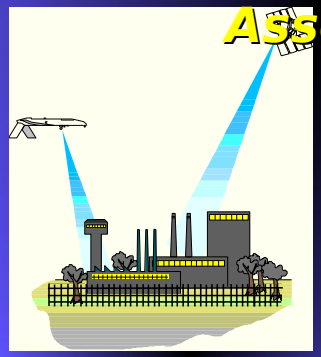
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

Sandia National Laboratories
Broad Mission Space in National Security

Nuclear Weapons

Safe, Secure, Reliable Weapons

Nonproliferation & Assessments



Detection

Surveillance

Energy & Infrastructure Assurance

Energy

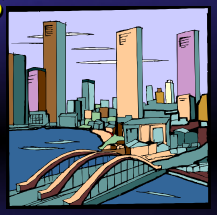
Transportation

Information

Architectural Surety

Military Technologies & [illegible]ions

Battlefield



Urban Operations

Force/Facility

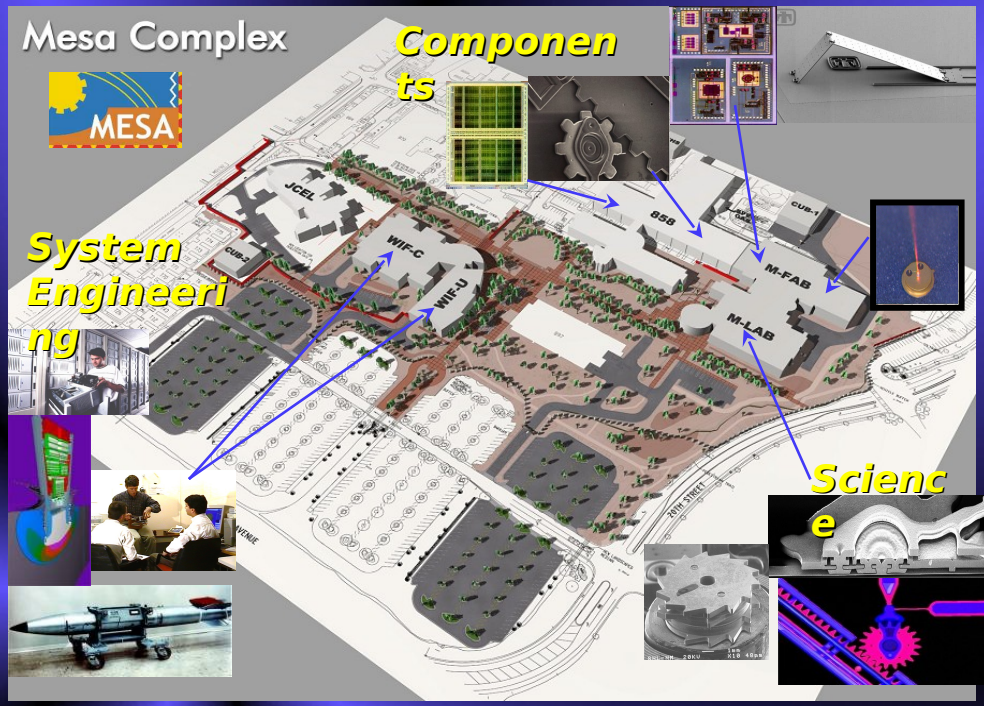
Anti-Terrorism Technologies

Product Preview

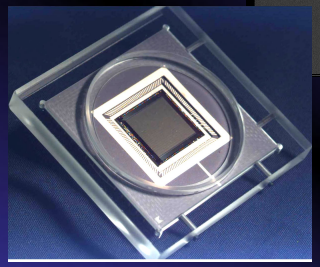
- MicroHound - Handheld explosives detection
- Polychromator - Stand-off CWA detection
- MicroChemLab - Handheld CWA detection
- SnifferStar - UAV-mounted CWA detection
- SH-SAW Biosensor - Handheld bioagent detection
- MicroUGS - Autonomous multi-sensor platform

MESA - DOE's Center for Microsystems

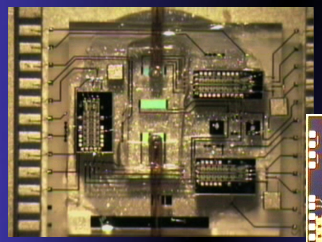
- Microsystems and Engineering Sciences Applications (MESA) Complex – largest single Federal investment in microtechnology
- $462M capital line item
- Operational in 2007
- 391,000 square feet of fab, lab, and office space
- Will house 648 engineers, scientists, and partners

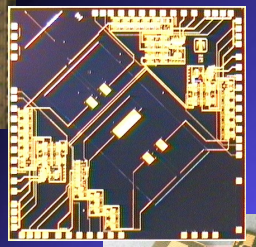


Microsensor Technologies

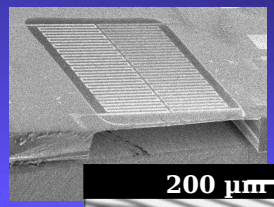


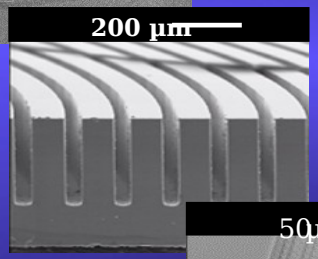
Optical Spectroscopy



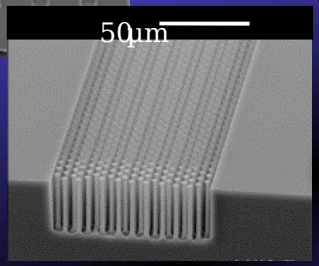


Acoustic Wave Mass Sensors



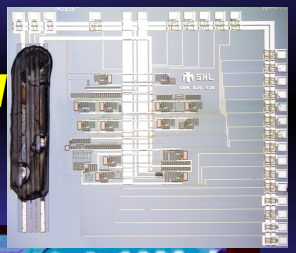


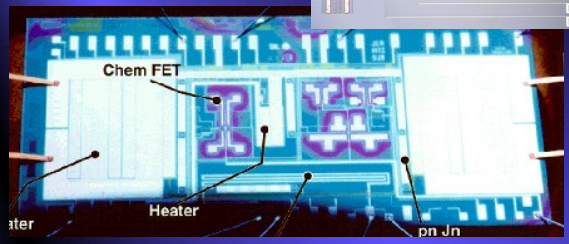
Microfluidics



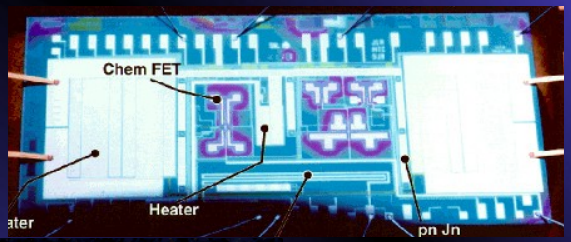
Radiation Sensors

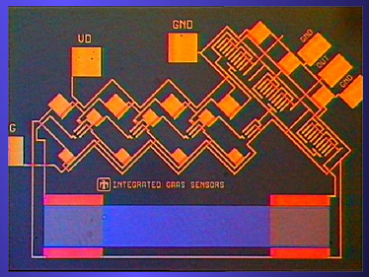
Electrochemical Sensors



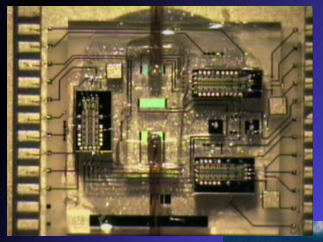


Microfabrication Technologies





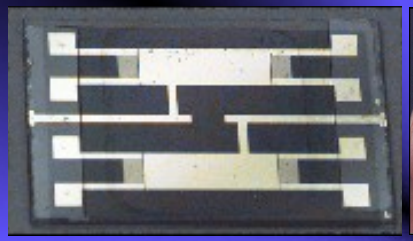
III-Vs

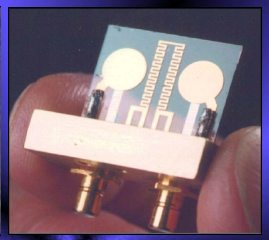


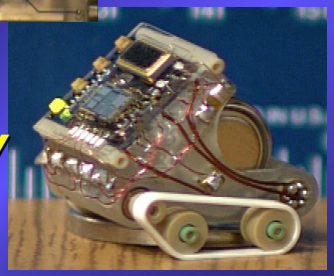
Hybrid Assembly

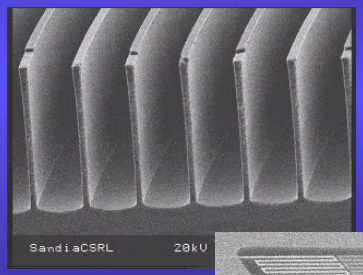
Si CMOS

Piezoelectrics

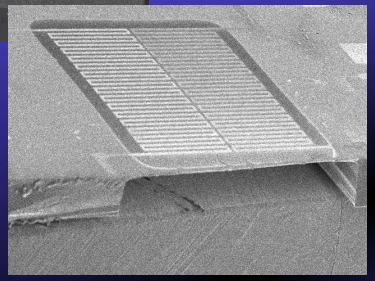




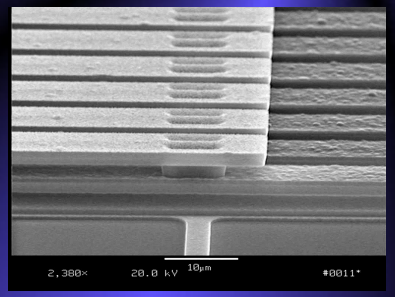




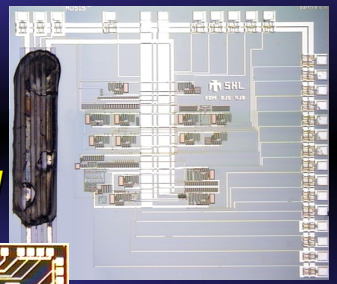
Si Bulk MEMS

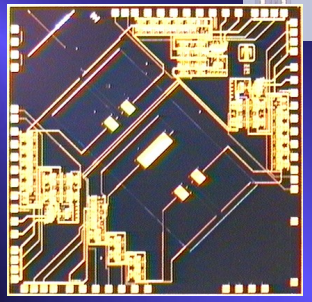


Si Surface MEMS



Post-Processing





MicroHound - Explosives Detection

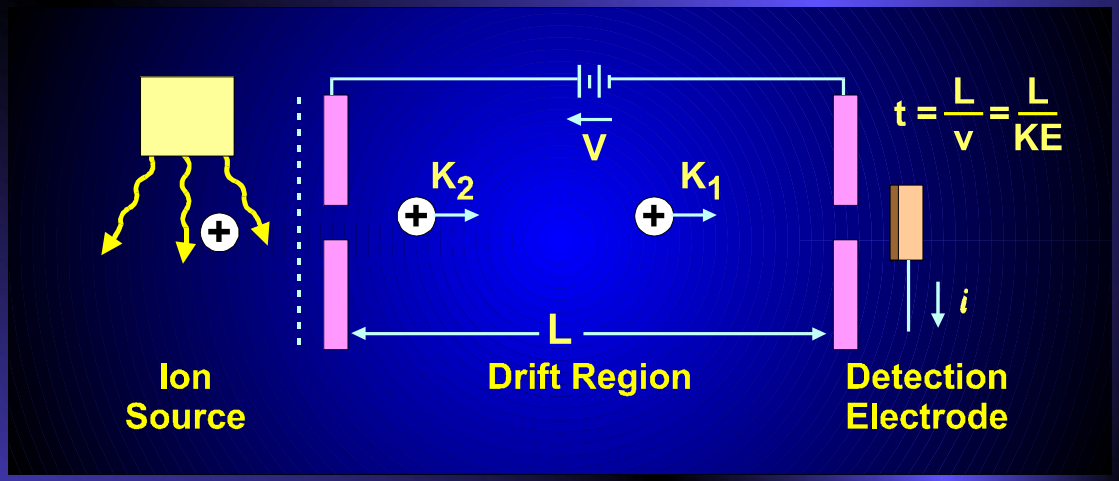
- Handheld explosive detector
- Can detect TNT, RDX, and PETN below 1 ng
- 10 prototype systems delivered to sponsor
- Miniature IMS detection subsystem
- Manufacturable IMS process based on printed circuit board technology

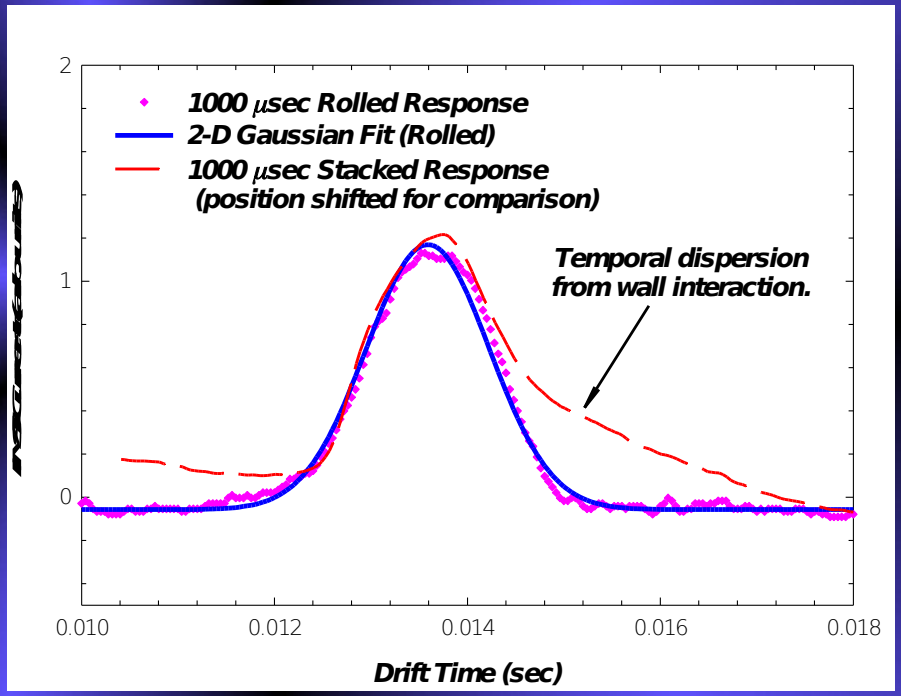
Micro Hound

IMS Drift Tube

IMS Subsystem

Ion Mobility Spectrometer

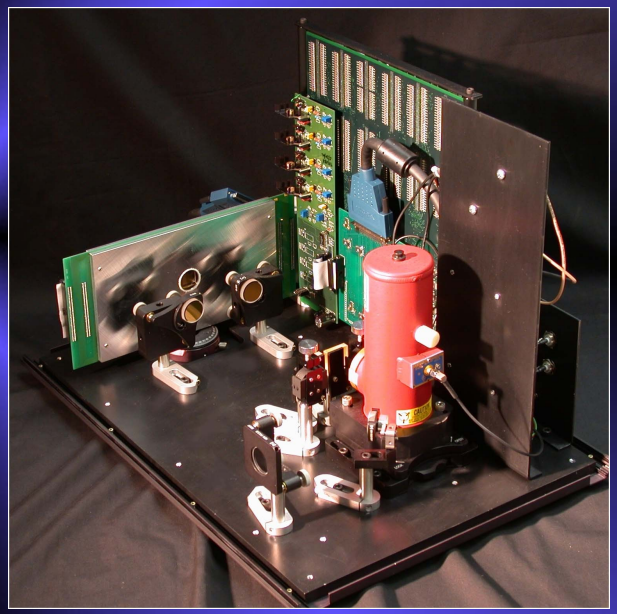




Polychromator - Stand-off CWA Detection

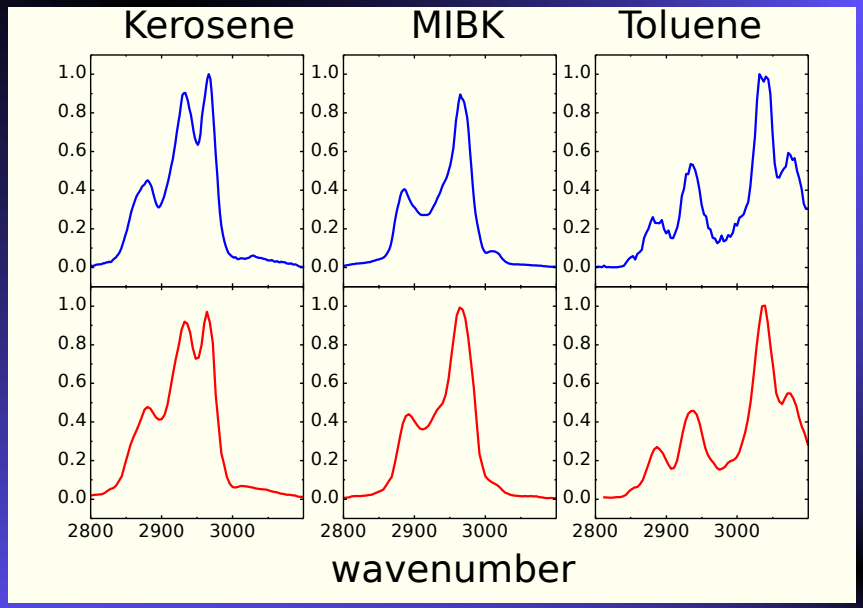
- IR detection in handheld package
- Initial develepment funded by DOE and DARPA in partnership with Honeywell and MIT
- 1 ppm-m sensitivity in lab
- 100:1 selectivity
- Prototype lab system now at SPAWAR
- Sandia field test scheduled in FY
- Dev for CPS

Mock-up of Handheld Unit



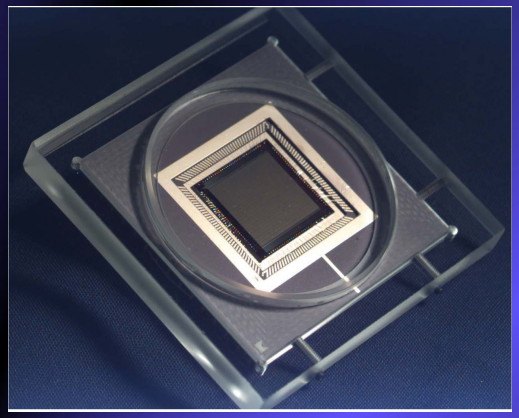
Lab Prototype

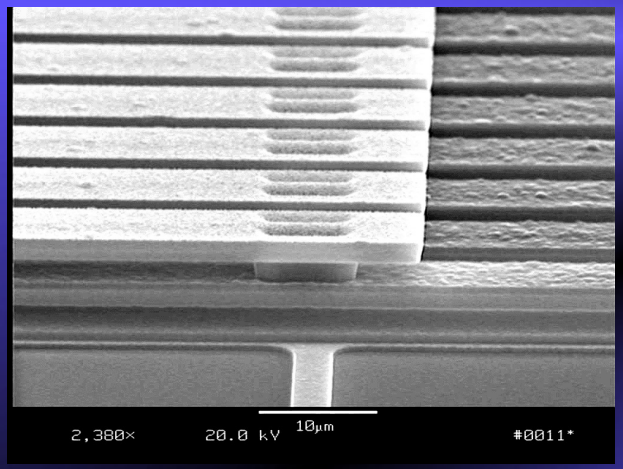
Polychromator - Lab Results

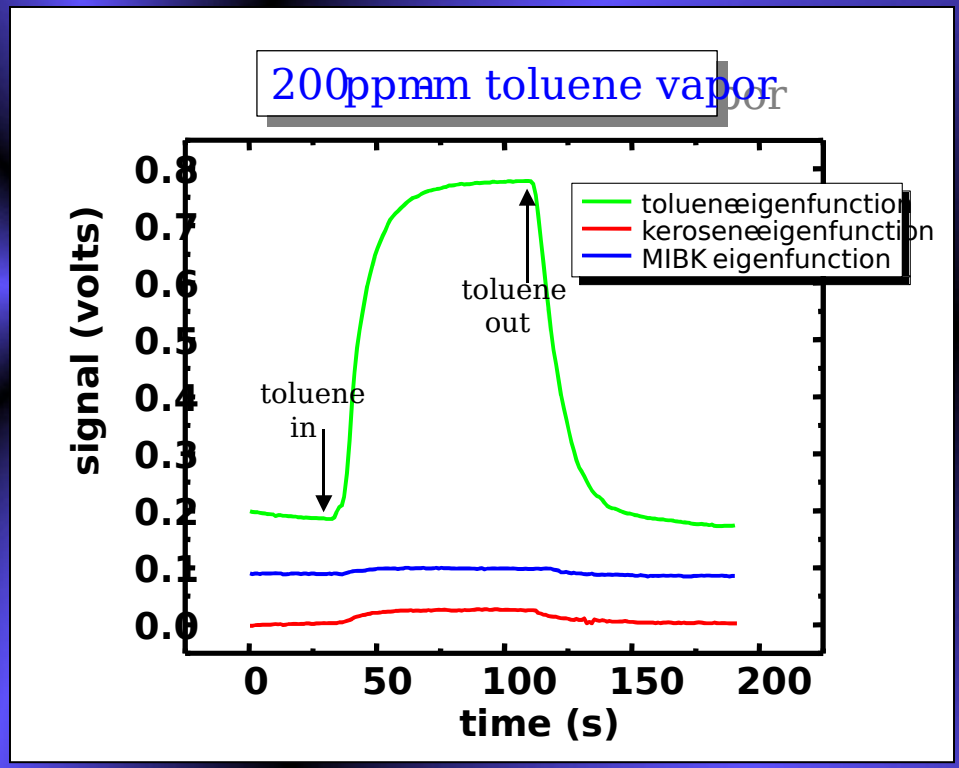


vapor spectra

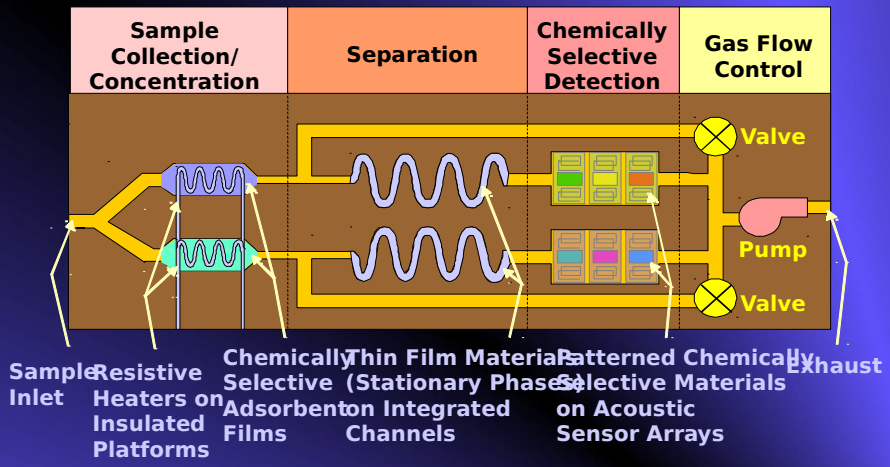
grating spectra

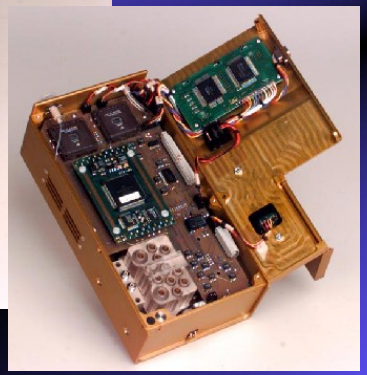






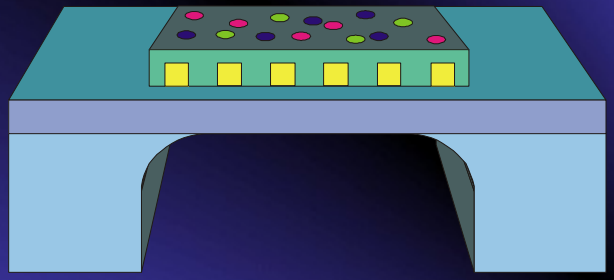
MicroChemLab - Handheld Chemical Analysis

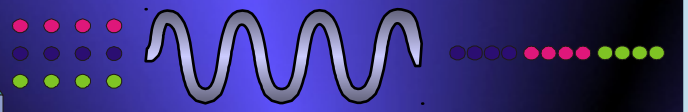


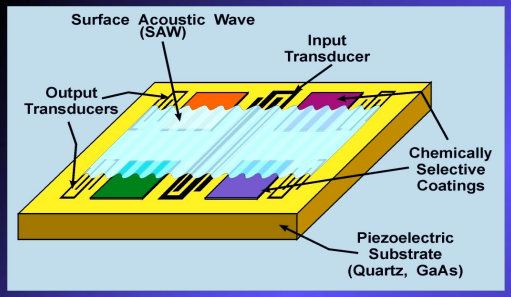


- *Detects CWA, TICs, TIMs*
- *Micromachined components enable miniaturization and rapid, low power response*
- *System has been assembled into a user-friendly hand-held unit*
- *ppb detection levels*
- *2 minute analysis time*
- *Lab tests at ECBC*
- *Field tests at subways and airports*

MicroChemLab



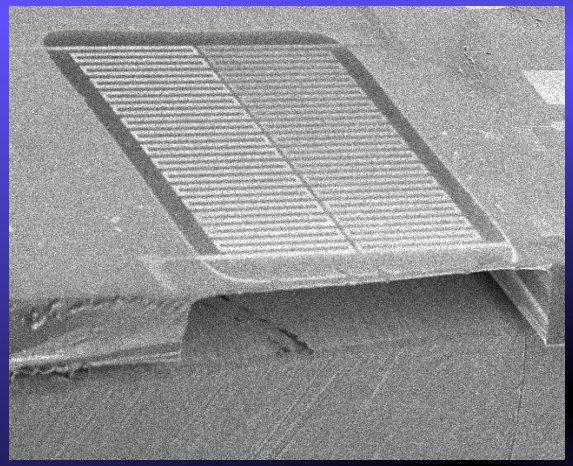


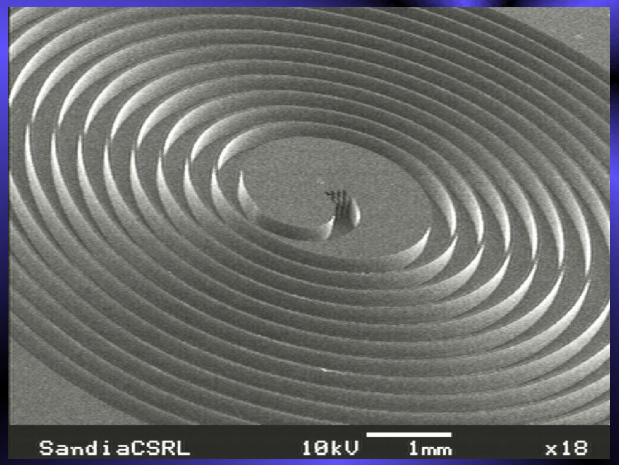


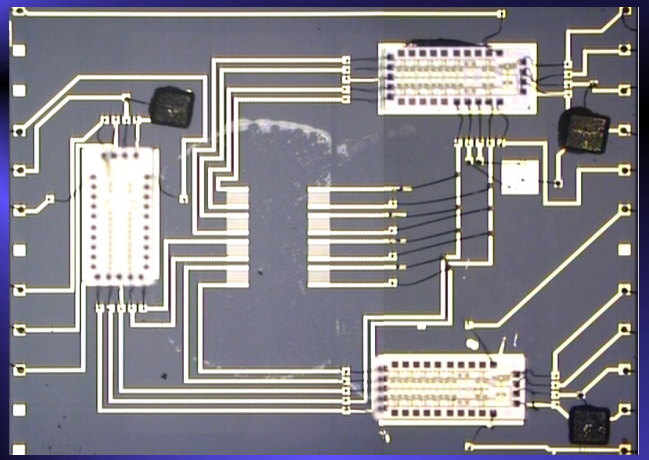
Preconcentrator accumulates species of interest

Gas Chromatograph separates species in time

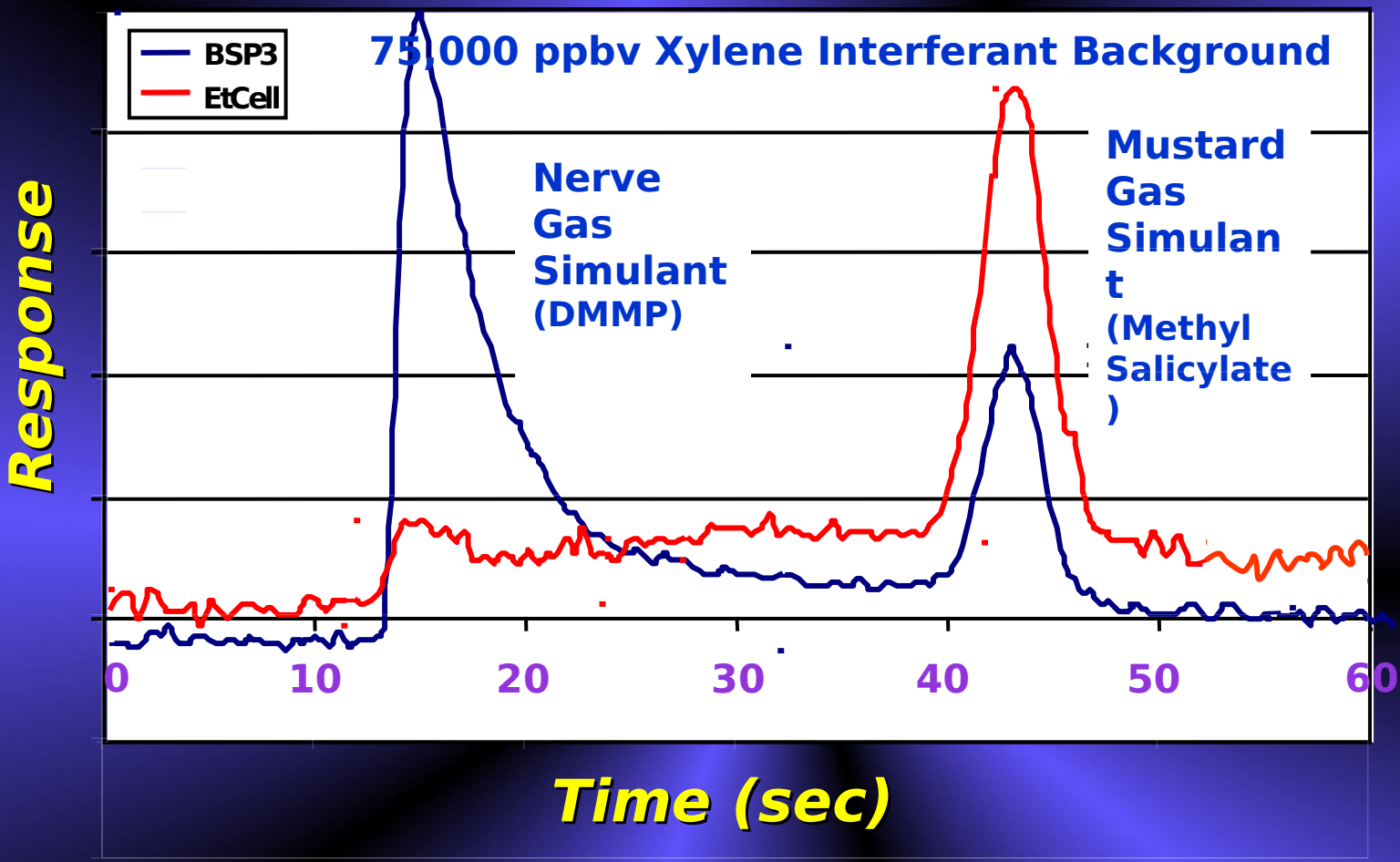
Acoustic Sensors provide sensitive detection



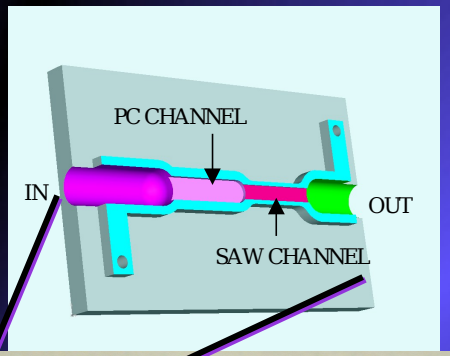


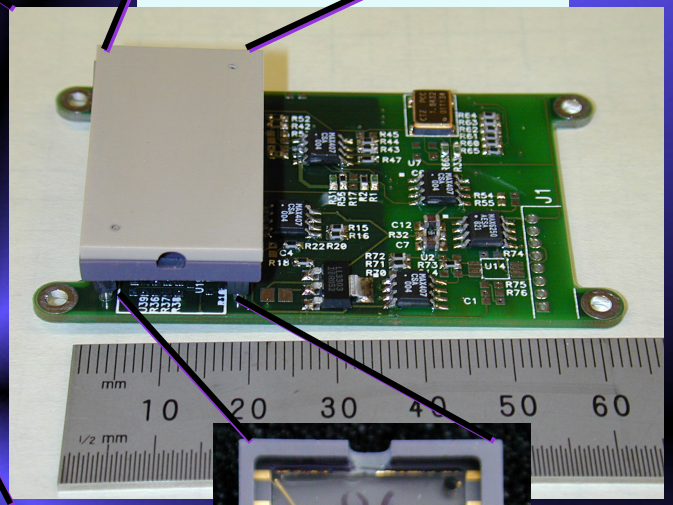


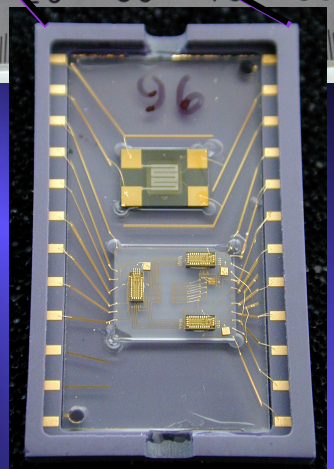
Detection of CW Simulants



SnifferStar™ - Chemical Sensor for µUAVs



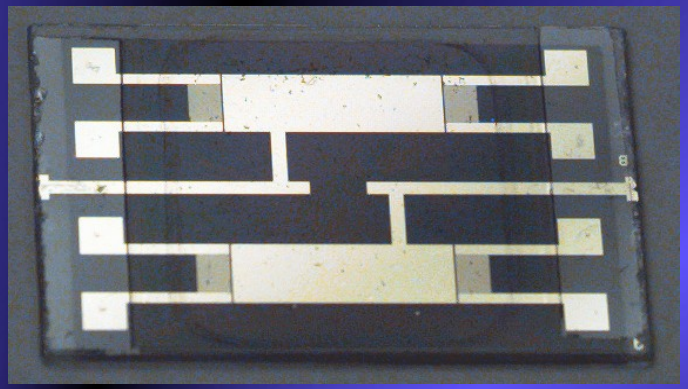




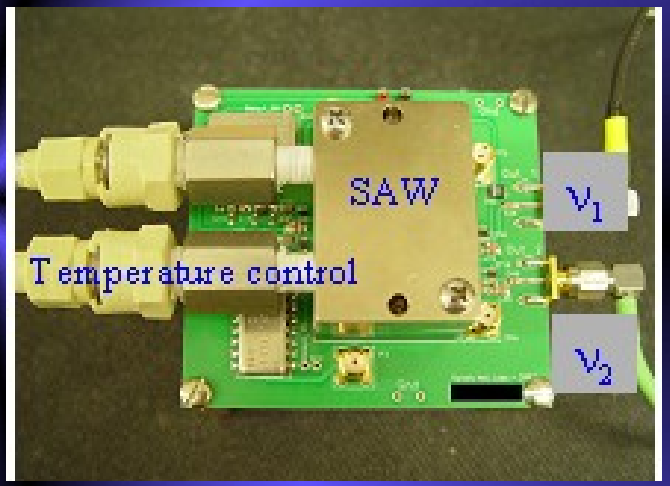
- Lockheed Martin collaboration
- Light weight
- Low power consumption
- 20 s processing time
- 2003 R&D 100 Award
- Field test prototypes being developed

SH-SAW Biosensor - Handheld Bioagent Detecti

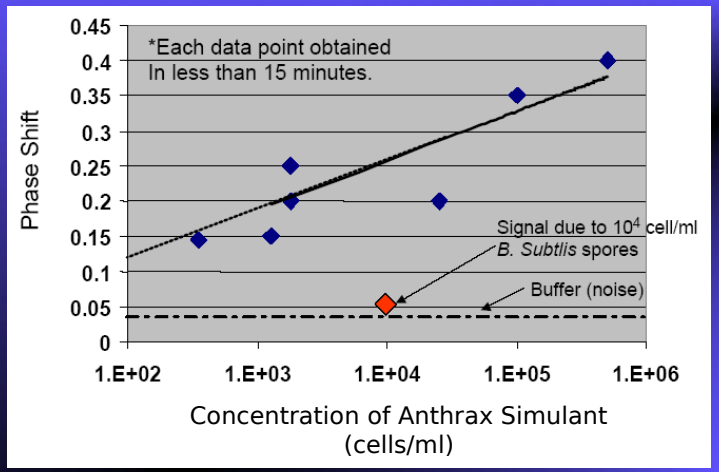
- Microsensor developed for anthrax detection
- Detection level < 1000 cells/ml
- Detection limit well below infectious limit
- Highly selective, rapid analysis
- Work underway to extend to other BWAs
- Commercial partner developing handheld system



SH-SAW Microsensor

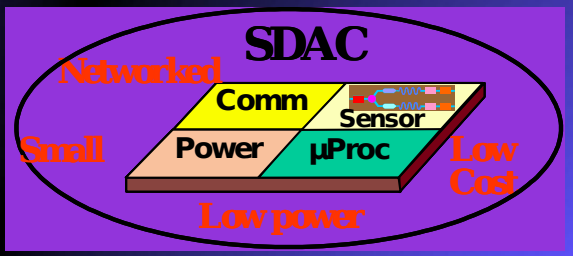


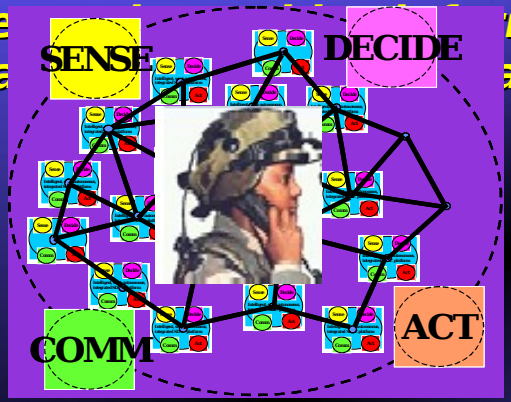
Delay-line Oscillator Board

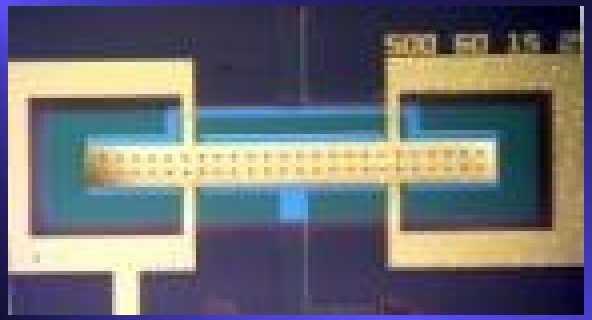


MicroUGS

- Sense, Decide, Act, Communicate on a Chip Stack
- Multi-sensor suite with integrated electronics
  - Acoustic, vibration, pressure, magnetic, RF
  - Chemical and biological sensors
- Secure, jam resistant RF communication
- Low cost, low power, small/covert
- Hand emplace, leave behind, autonomous
- Communicate on query or event
- Ne… …matio… wa… …and po…







Summary

- Sandia has developed and delivered microsystem products that provide field-deployable chemical detection capability
- Novel chem/bio microsensor technologies are being developed at all stages of technical readiness.
- Emphasis placed on handheld and autonomous technology
- Current government investment in microsystem infrastructure will keep Sandia a viable source of technology (research through product delivery) into the foreseeable future